



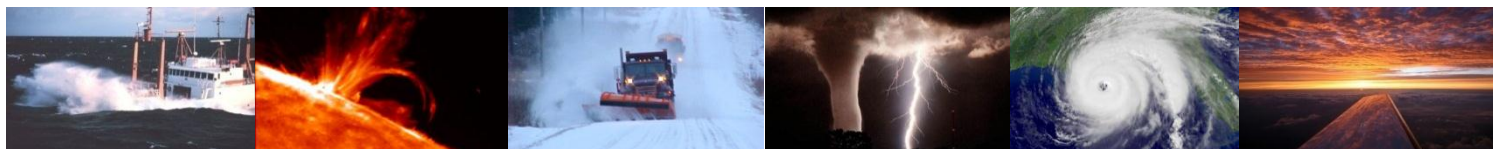
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# Overview of the Climate Prediction Center

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**Dr. Wayne Higgins, Director  
Climate Prediction Center / NCEP**

***March 2012***



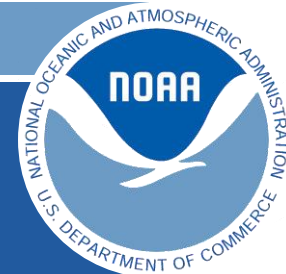


# Outline

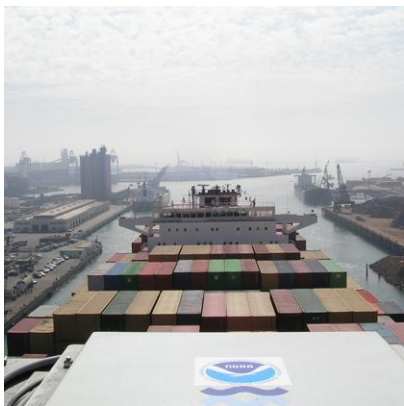
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- The Demand for Climate Services
- CPC Mission and Activities
- Climate Modeling and Prediction Advances at NCEP
- CPC Strategy to Improve Products
- Linkages to ESPC Demonstration Projects
- What's Missing?
- Summary





# The Rising Demand for Climate Services



Commerce



Coasts



Recreation



Ecosystems



Hydropower



Farming

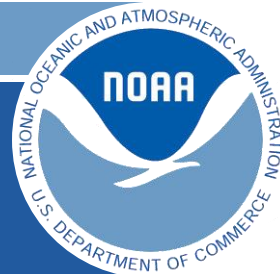


Wind Energy

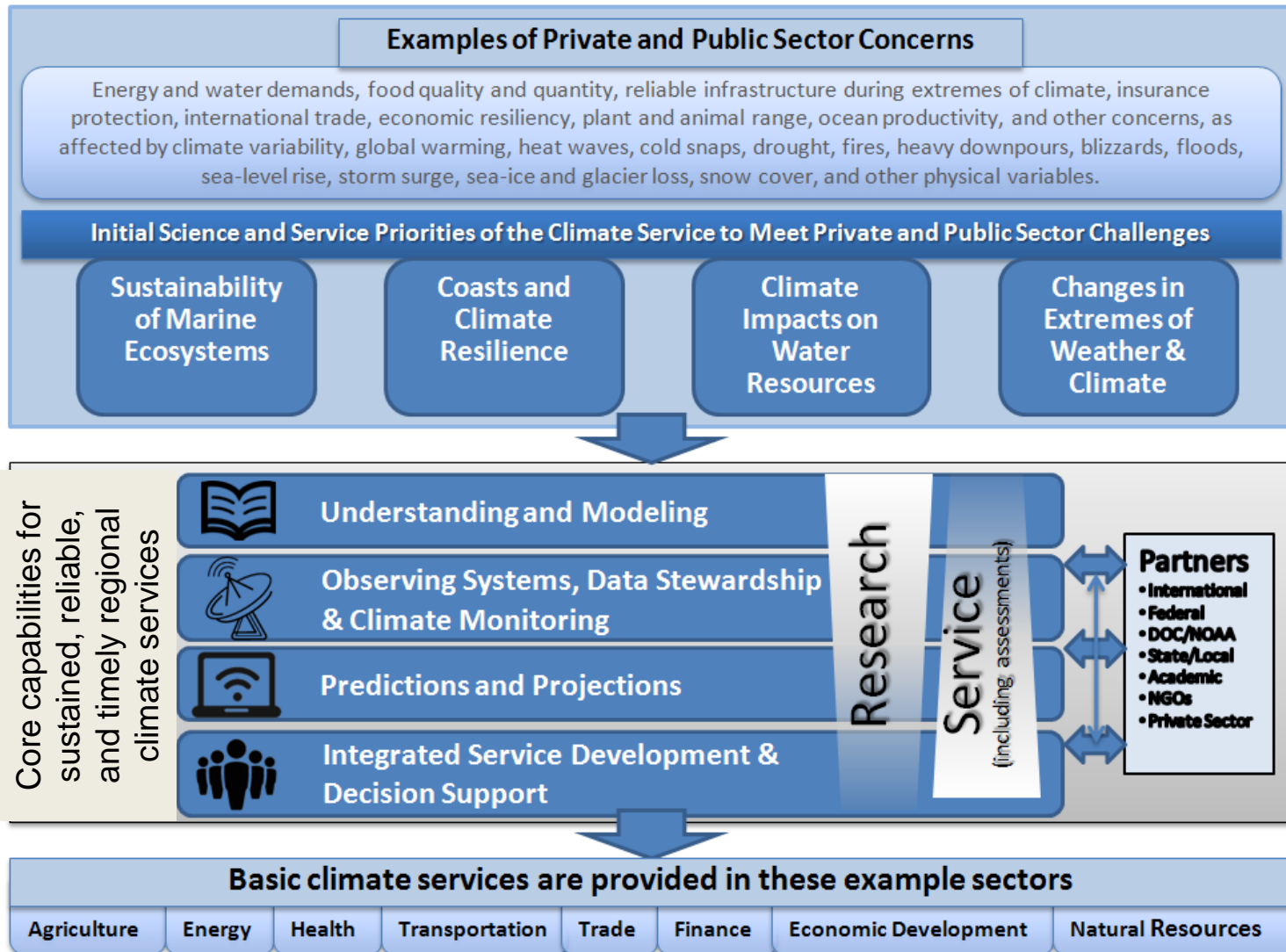


Private Sector

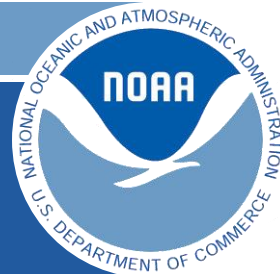
There is an urgent and growing need for reliable, trusted, transparent and timely climate information across all sectors of our economy.



# NOAA Strategy: Draw on Core Capabilities to Address Societal Challenges





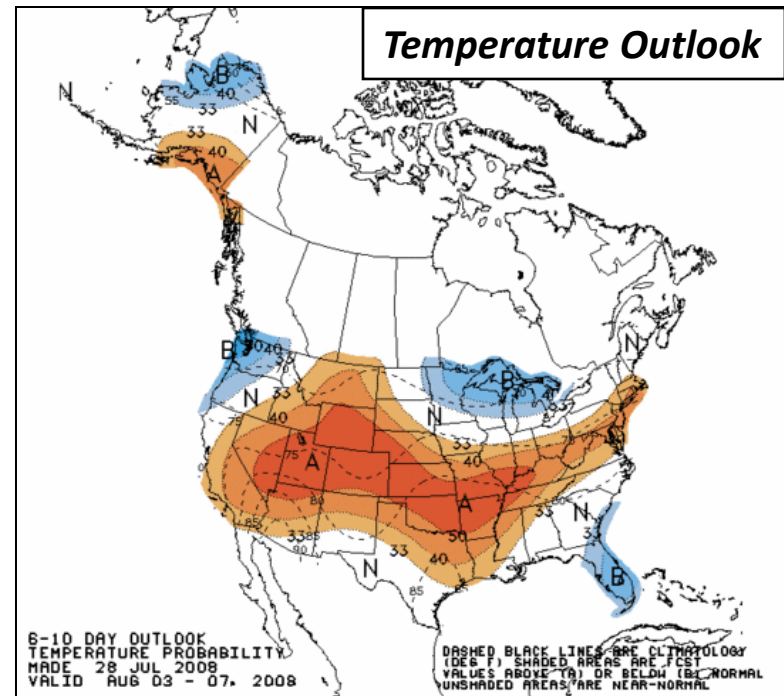


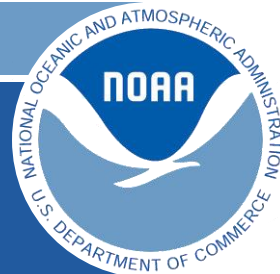
# CPC Mission

***We deliver climate prediction, monitoring, and diagnostic products for timescales from weeks to years to the Nation and the global community for the protection of life and property and the enhancement of the economy.***

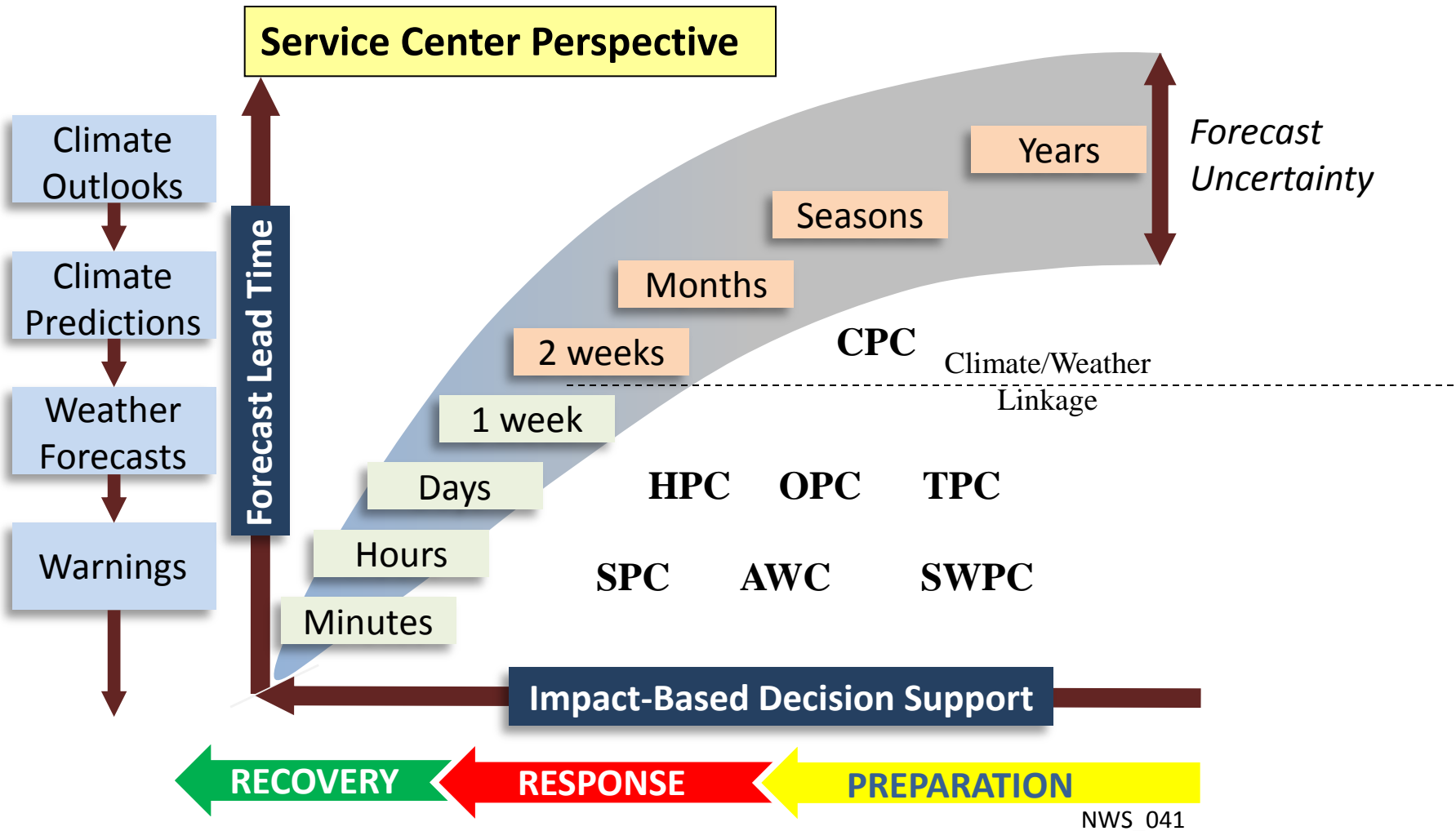
## Operational Requirements:

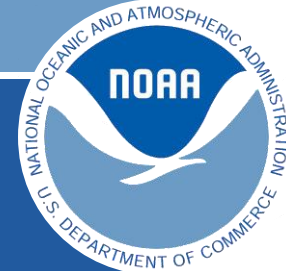
- Deliver national outlook products: temperature, precipitation, drought, hurricanes,...
- Span weeks, months, seasons, years
- Embrace collaborative forecasting with other NCEP Service Centers, NOAA line offices, other agencies and labs
- Ensure real-time, on-time, all the time (since '79)
- Enable NGSP Societal Challenges: "Water" and "Extremes"





# NOAA Seamless Suite of Forecast Products Spanning Climate and Weather

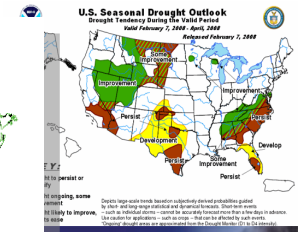
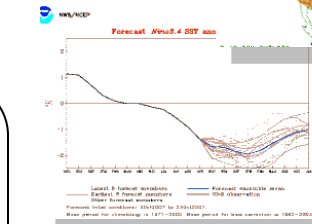
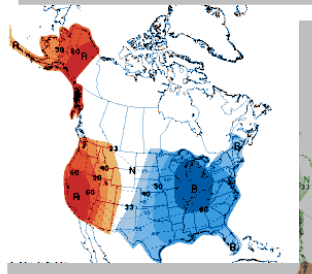
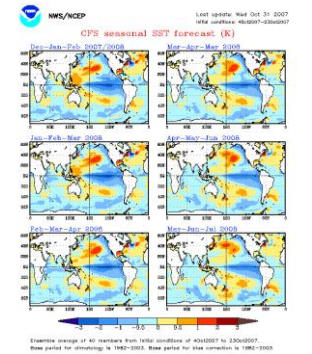




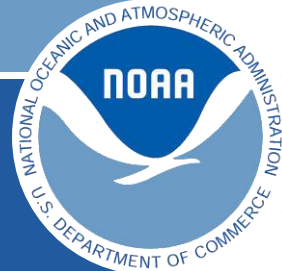
- **Official Outlooks focused on week-2, monthly, seasonal**

- ☐ **6-10 Day & 8-14 Day  
Precipitation & Temperature Outlooks**
- ☐ **Day 3-14 Hazards Outlooks  
(US, Global Tropics)**
- ☐ **Monthly & Seasonal  
Precipitation & Temperature Outlooks**
- ☐ **Seasonal Drought Outlook**
- ☐ **Seasonal Hurricane Outlooks  
(Atlantic and Eastern Pacific)**
- ☐ **Monthly ENSO Prediction**

- **Dynamical Models**
- **Statistical Models**
- **Historical Analogs**
- **Historical Composites**

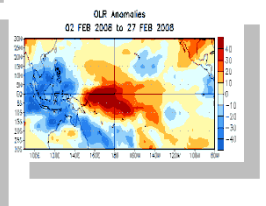
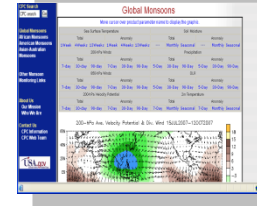
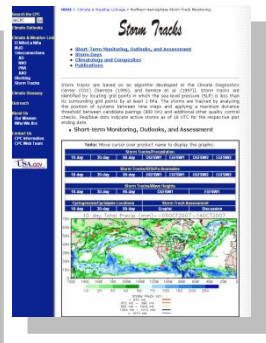
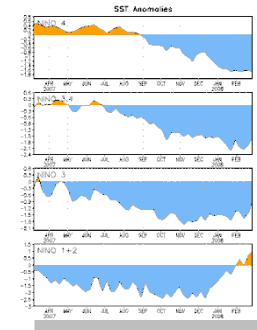
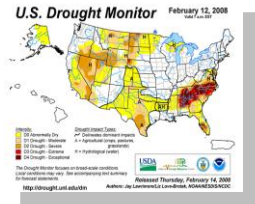
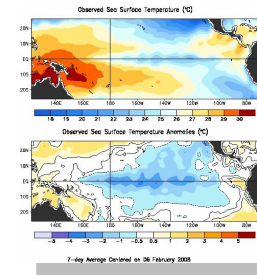


- \* Dynamical Models
- Climate Forecast System
- Global Forecast System
- ECMWF

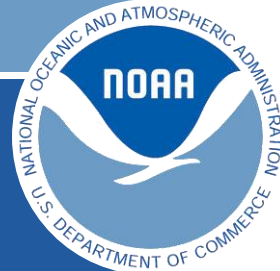


# CPC Climate Monitoring Products

- Monitor atmospheric, oceanic and land surface conditions using daily and monthly data, time series, and spatial maps (both real-time and historical)
  - Primary modes of climate variability (ENSO, MJO, NAO, PNA, AO,...)
  - Storm Tracks and Blocking
  - Monsoons
  - Precipitation and Surface Temperature
  - Drought (US, North America; NIDIS)
- Products rely on a wide range of real-time reanalyses (R1, R2, CFSR, NARR, GODAS)

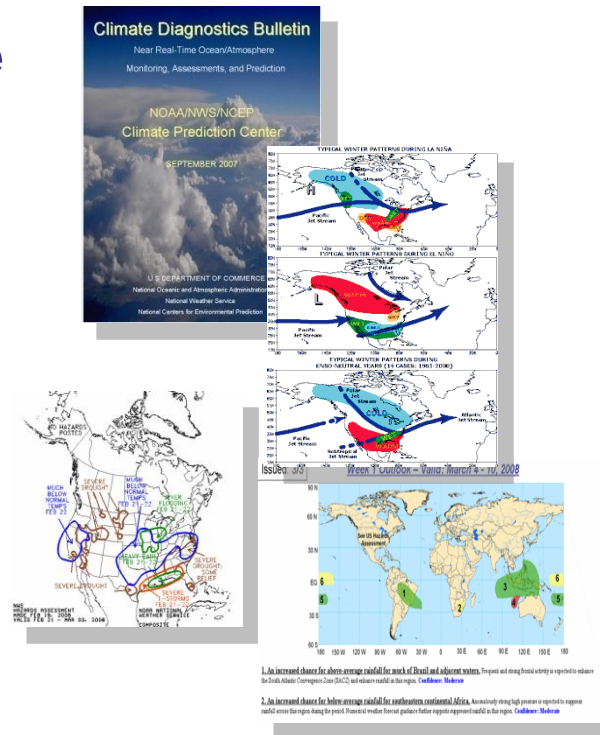


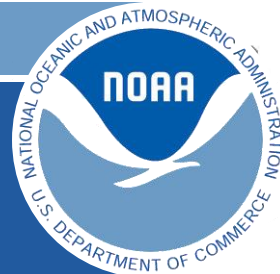




# CPC Climate Diagnostic Products

- **Synthesis of current weather and climate information and forecasts; issued on a routine basis**
  - **Climate Diagnostics Bulletin (monthly, web)**
  - **ENSO Diagnostics Discussion (monthly, PDF and WORD)**
  - **Weekly ENSO / MJO / Monsoon / Ocean updates (.ppt, PDF, web)**
  - **Seasonal Climate Summaries (web)**
  - **Special Climate Assessments (extreme events, web)**
  - **Annual Climate Assessment (multi-agency; published in the AMS Bulletin)**

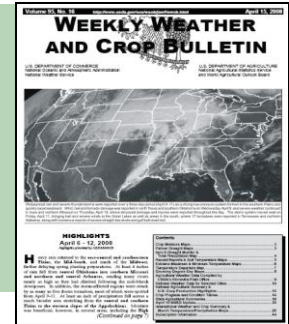




# CPC Interagency & International

- **Joint Agriculture Weather Facility**

- *USDA – DOC partnership*
- *Weekly Weather and Crop Bulletin*
- *Briefings & Summaries on global weather & crop conditions*



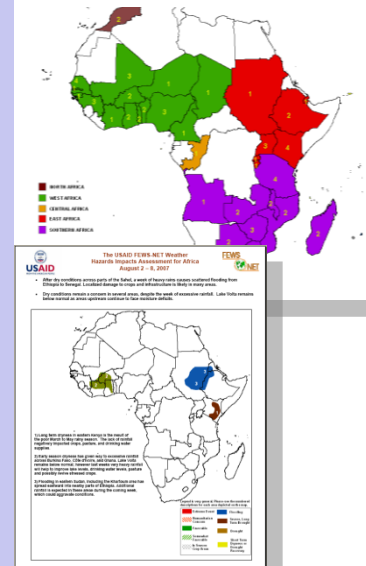
- **CPC International Desks**

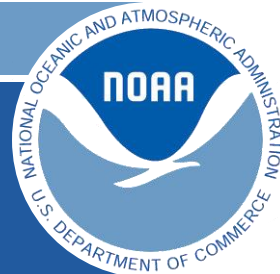
- *African Desk*
- *Monsoon Forecaster Training Desk*
- *Caribbean and South American Desks*
- *Activities*

- **Training and Education**
- **Partnerships**
- **Products**

*Famine Early Warning System  
Hazards Outlooks (Africa, global tropics)  
Tropical Cyclone Monitoring*

## Training Coverage in Africa





# Climate Modeling and Prediction Advances at NCEP

## Climate Forecast System - NOAA's first dynamic, fully-coupled operational climate forecast model

- Version 1 operational since Aug 2004
- Version 2 operational in Mar 2011
- CFSv2 Reanalysis & Reforecasts (1979-present)

## Climate Test Bed – Accelerate the transition of Research to Operations (R2O)

### Science Priorities:

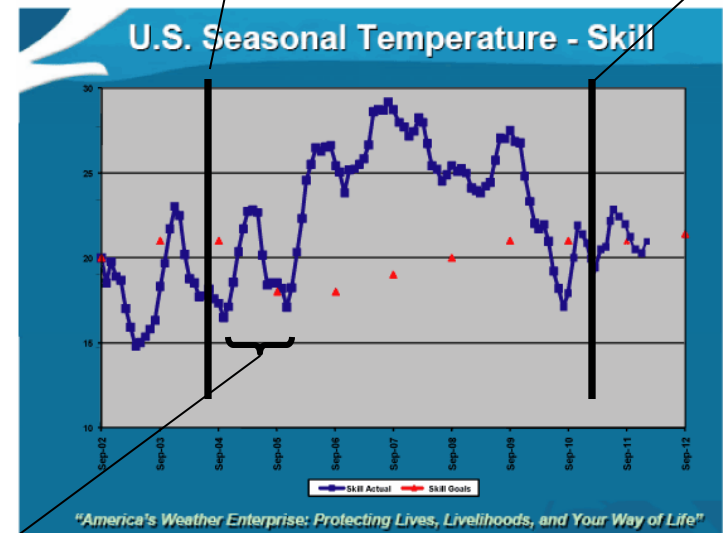
- Climate Forecast System improvements
- Multi Model Ensemble prediction systems
- Climate forecast products

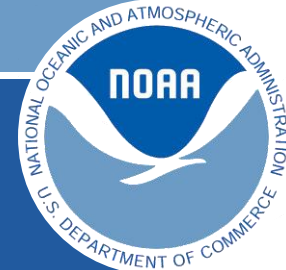
These advances have improved forecast skill  
(e.g CPC GPRA Measure for U.S. Seasonal Temperature)

Climate Test Bed spin up

CFS (v1) Implemented

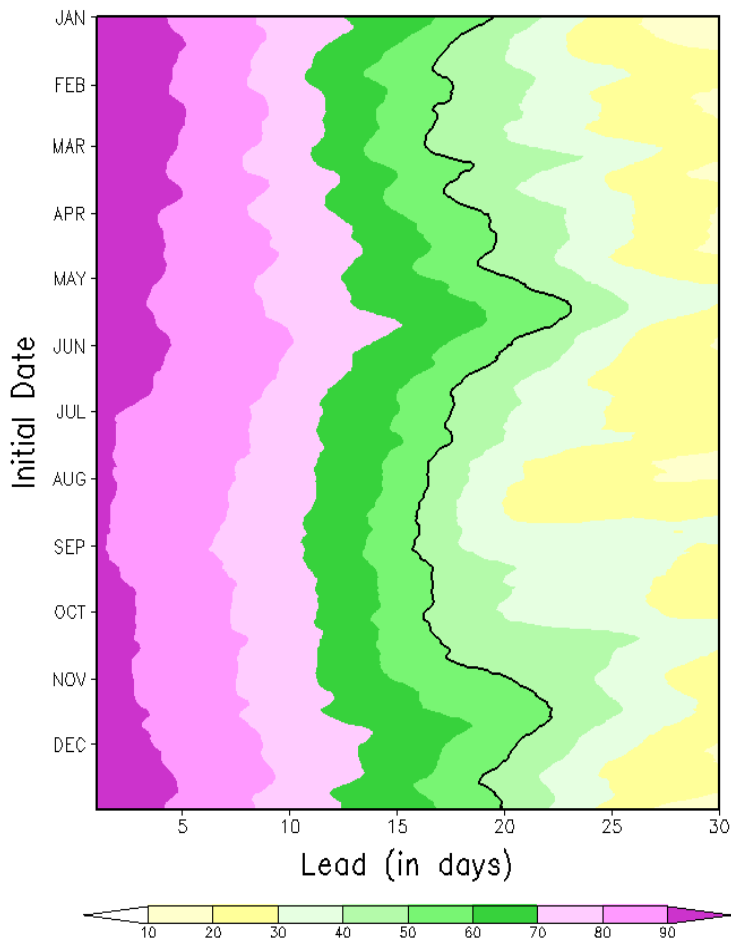
CFS (v2) Implemented



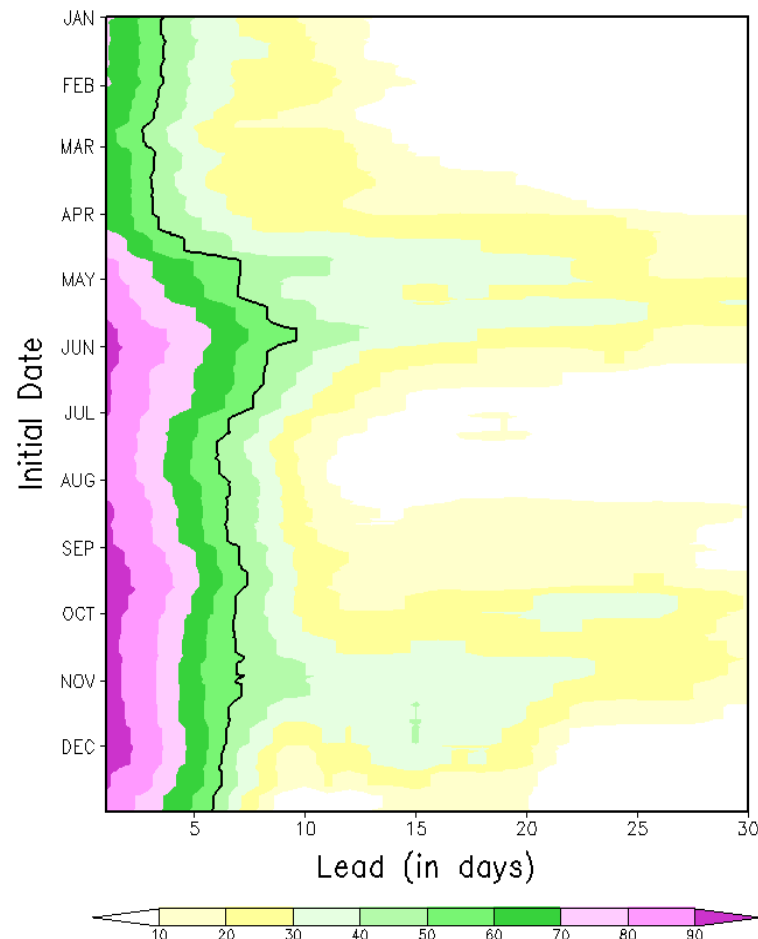


# MJO Prediction CFSv2 –vs– CFSv1

CFSv2 Forecast Skill (%) of WH-MJO Index  
1999–2009



CFS Forecast Skill (%) of WH-MJO Index  
1999–2009

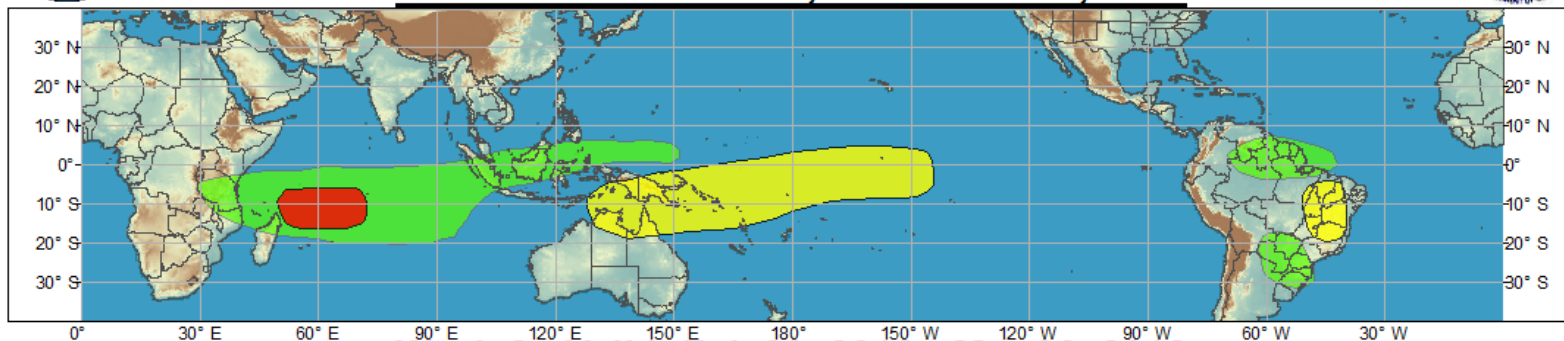




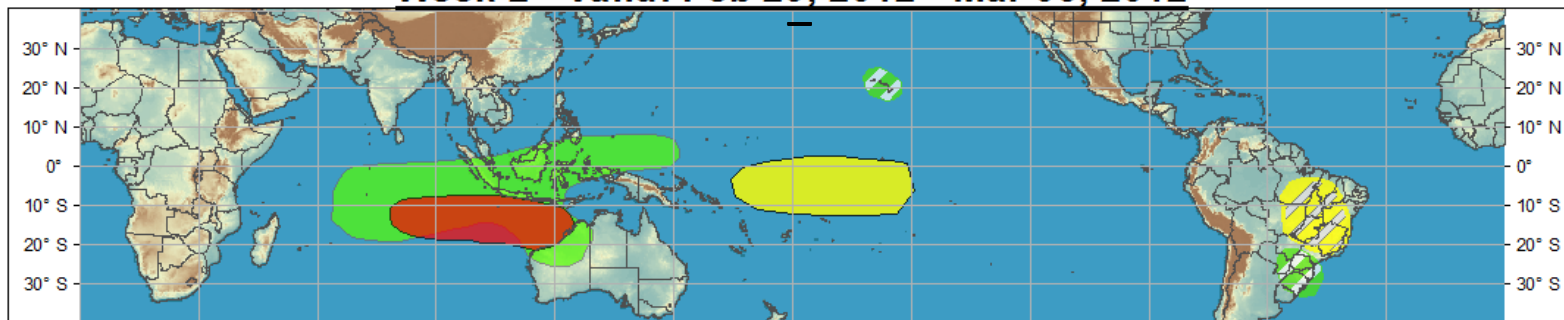


# CPC Global Tropics Hazards / Benefits Outlook











**Week 1 - Valid: Feb 22, 2012 - Feb 28, 2012**



**Week 2 - Valid: Feb 29, 2012 - Mar 06, 2012**

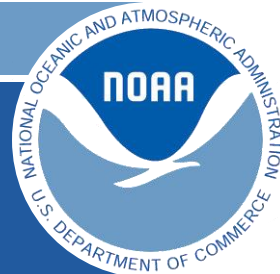


**Produced: 02/21/2012**

Confidence		
High	Moderate	
		Tropical Cyclone Formation Development of a tropical cyclone that eventually reaches tropical storm strength.
		Above-average rainfall Weekly total rainfall in the upper third of the historical range.
		Below-average rainfall Weekly total rainfall in the lower third of the historical range.
		Above-normal temperatures 7-day mean temperatures in the upper third of the historical range.
		Below-normal temperatures 7-day mean temperatures in the lower third of the historical range.

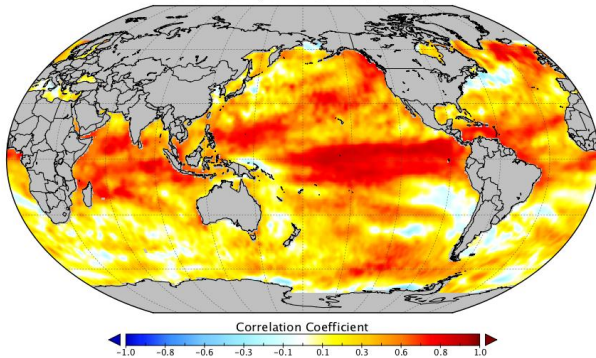
Product is updated once per week. The product targets broad scale conditions integrated over a 7-day period for US interests only.  
Consult your local responsible forecast agency.





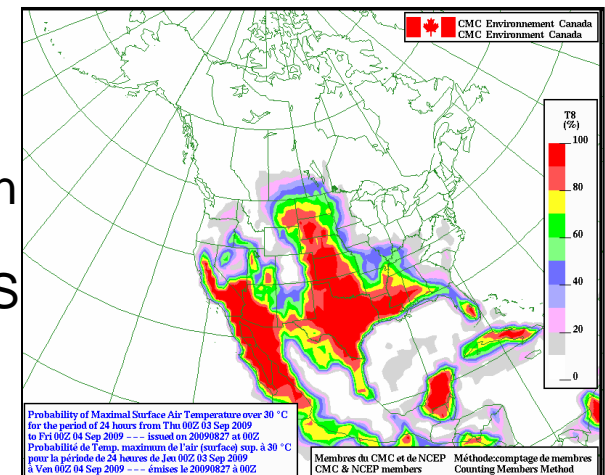
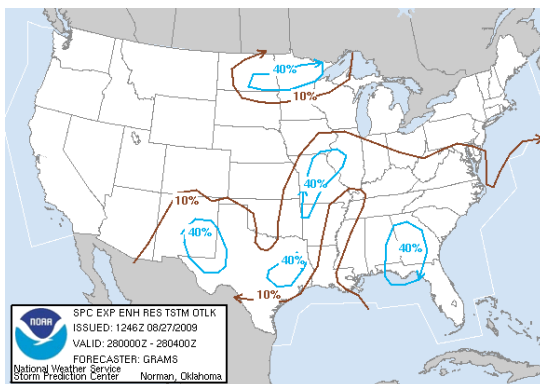
# Multi-Model Ensembles for Climate and Weather

US NMME SSTA Correlation Coefficient  
6 Month Lead August Initial Conditions (1982-2010)



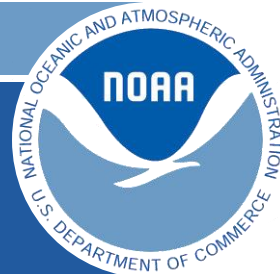
- **Climate:** Climate Multi-Model Ensemble
  - International MME with EUROSIP
  - National MME with US partners
- **Medium Range Weather:** North American Ensemble Forecast System (NAEFS)
  - GFS + MSC + Navy FNMOC NOGAPS

Experimental Enhanced Resolution Thunderstorm Outlooks



Probability of Temperature over 30C over 24 hour period  
(7 day forecast valid Sept 3-4, 2009)

- **Mesoscale:** Short Range Ensemble Forecasts
  - WRF/ARW + WRF/NMM + RSM



# CPC Strategy to Improve Climate Products

## Goal

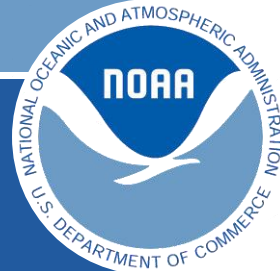
- Issue a new generation of climate outlook products as a seamless suite on timescales from weeks to multi-year

## Research and Transition Activities

- Identify climate model predictability / prediction skill on ISI timescales
- Embrace a unified weather-climate modeling strategy in collaboration with external research community
- Improve the skill of dynamical ISI forecasts, through a combination of improvements to CFS and MME approaches
- Develop regional climate information products
- Exploit new delivery technology (e.g. web services; mobil apps)

## Caveat

- Carefully manage expectations with respect to new products by adhering to scientifically defensible goals (e.g. predictability)



# Scientific Basis for Seasonal Prediction

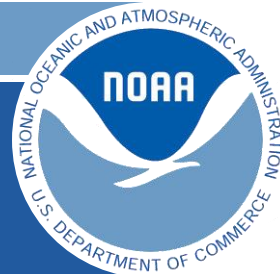
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**The scientific basis for Seasonal Prediction is the existence of predictable variability on long time scales.**

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- **ENSO**
- **Trends**
- **Warm season soil moisture anomalies**
- **Coastal SST**
- **Cold season snow cover**
- **PDO?**
- **Arctic sea ice?**
- **.....**

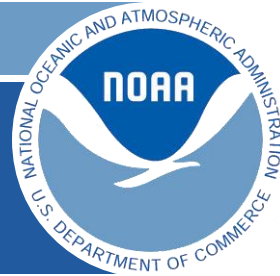




# Framing Performance Outcomes for ISI Predictions

**Key areas where the CPC will continue to work with partners  
to frame performance outcomes for ISI predictions**

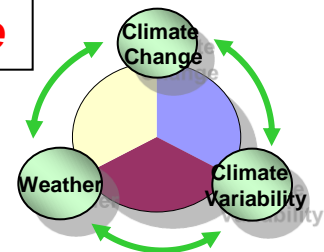
- **Improve evaluation:**
  - Verification techniques
  - Performance metrics
- **Explain scientific basis:**
  - Uncertainties
  - Probabilistic nature of forecasts
  - Predictability / Prediction
- **Engage in problem focused assessments:**
  - Provide context on what is occurring and why (e.g. attribution reports)
  - Provide advice on research directions to improve predictions
  - Address challenges with credibility, communication, education and buy-in



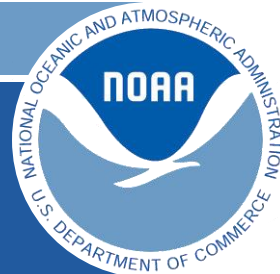
# Research Challenges for ISI Prediction

- **Organization of Tropical Convection**
- **Tropical - Extratropical Interactions**
- **Exploit Sources of Predictability**
- **Improve the “Building Blocks”**
- **Implement “Best Practices”**

***See Extras for Description of each Challenge***



THE NATIONAL ACADEMIES:  
<http://www.nap.edu/catalog/12878.html>

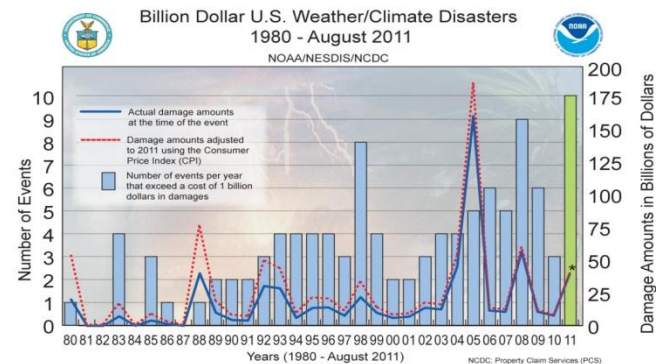


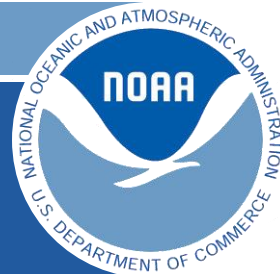
# Linkages to ESPC Demonstration Projects:

## Timely Attribution of Extreme Events

- NOAA is working towards a strategy for developing and delivering coordinated and timely information on extremes.
- Requires interagency, academic, and public coordination.
- Strong linkage to ESPC “Episodic Weather Extremes” demonstration project

### Weather and Climate Disasters in the US Exceeding \$1B in Damage (2011)



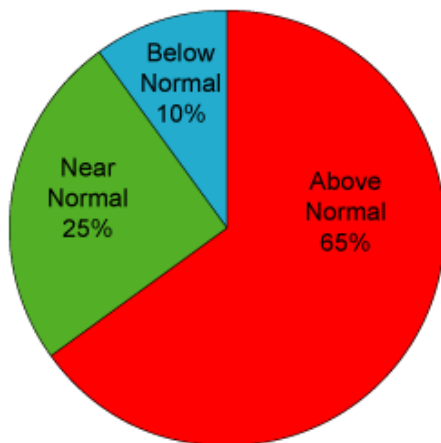


# Linkages to ESPC Demonstration Projects:

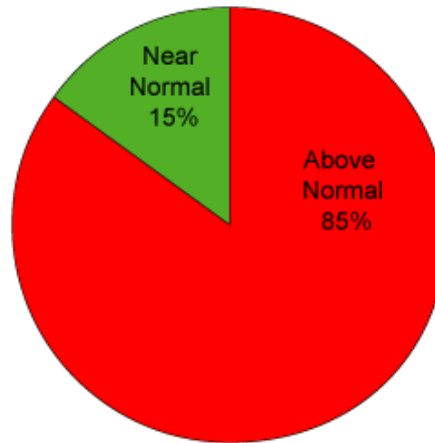
## Seasonal Tropical Cyclone Threat

### NOAA's 2011 Atlantic Hurricane Season Outlooks Probability of Season Type

Issued May 19



Issued August 4



### Activity

#### Observed

Named Storms	19
Hurricanes	7
Major Hurricanes	4
ACE (% median)	138

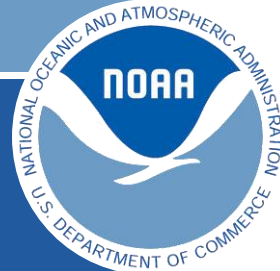
#### Predicted: 70% Probability For Each Range Issued May 19

Named Storms	12-18
Hurricanes	6-10
Major Hurricanes	3-6
ACE (% median)	105-200

#### Issued August 4

Named Storms	14-19
Hurricanes	7-10
Major Hurricanes	3-5
ACE (% median)	135-210



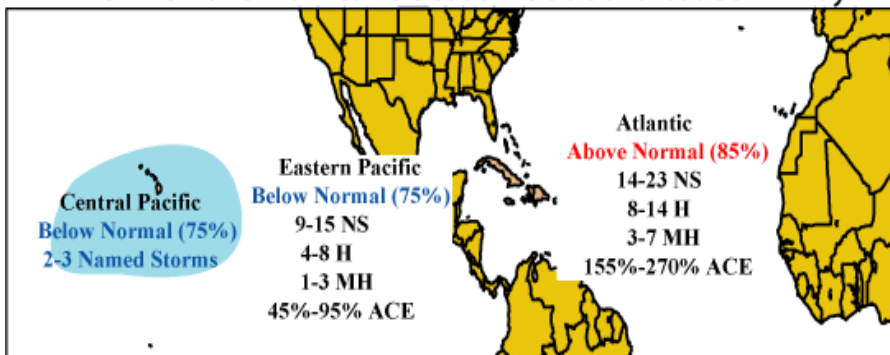


# Linkages to ESPC Demonstration Projects:

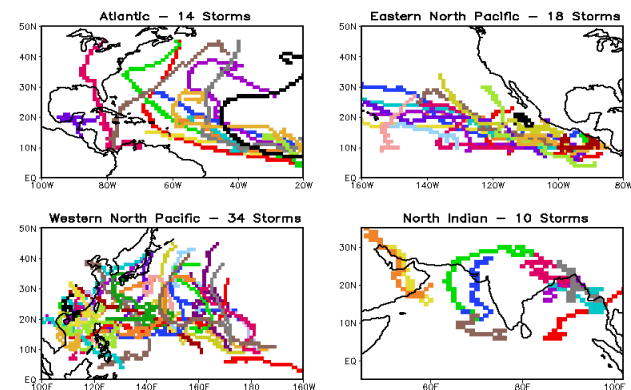
## Seasonal Tropical Cyclone Threat

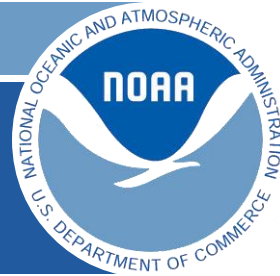
- CFS is used operationally (April+July) to produce an ensemble of high resolution runs in support of NOAA's Atlantic and Eastern Pacific Hurricane Seasonal Outlooks.
- CFS reliably captures the net seasonal frequency and intensity of tropical cyclone activity in these basins.
- **Next Frontier: Seasonal Landfall Forecasts**

NOAA's 2010 Hurricane Season Outlooks Issued in May



Northern Hemisphere Tropical Cyclone Storm Tracks for 1981



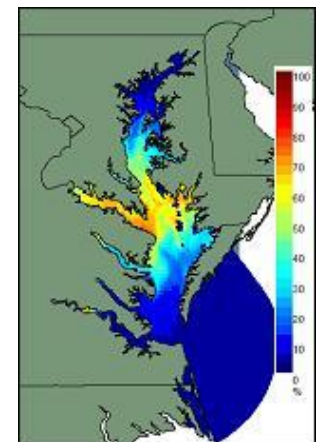


# Linkages to ESPC Demonstration Projects:

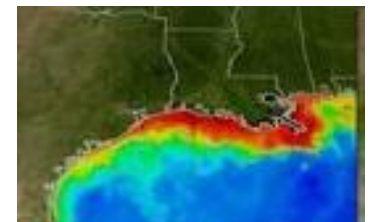
## Ecological Forecast System

### Chesapeake Bay

- “Cascading Hazards”
  - Precipitation prediction
  - Runoff prediction
  - Dissolved oxygen / salinity prediction
  - Harmful Algal Bloom / Vibrio Cholera prediction
  - Living Resource Distribution (Oysters, Sea Nettles)
- Leading to Human and Economic Impacts
  - Disease Pathogen Progression
  - Beach/Water Quality



Oysters, Fish,  
Sea nettles ...  
Vibrio...



Algal Blooms &  
Dead Zones

Gulf Coast; Great Lakes; Puget Sound.....

Relates to several ESPC projects

# What's Missing?

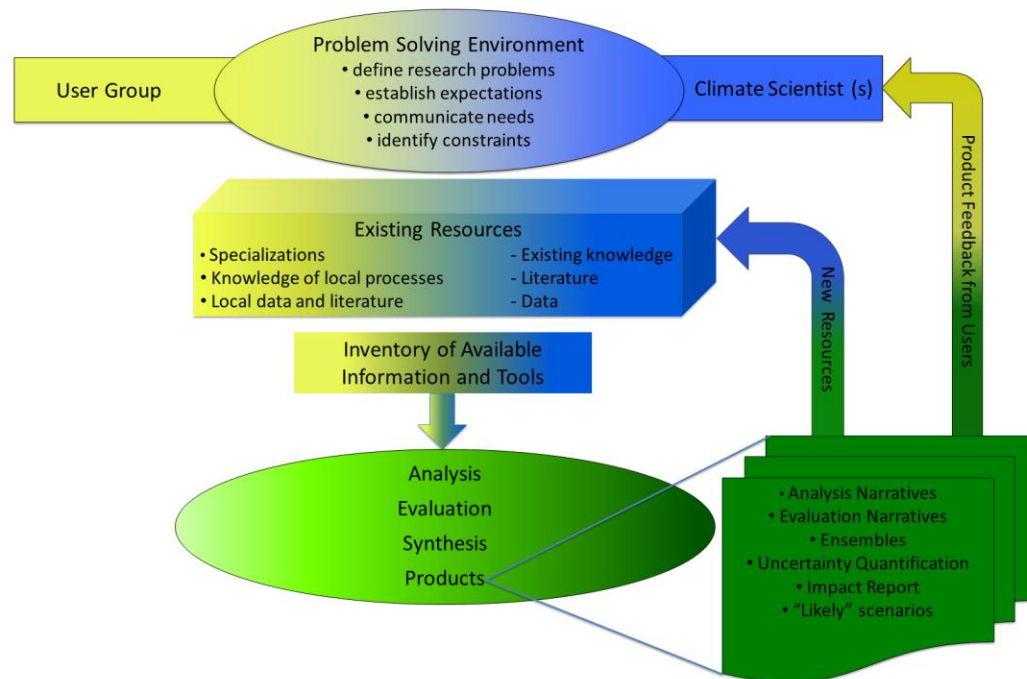
- Better climate information is rarely sufficient. Repeated studies have shown that making information useful demands engagement with those who will use it. This is about more than communicating science effectively. It is about responsive scientists and science institutions.
- The *National Climate Predictions and Projections Platform* , which works at the intersection between climate science and decision making, is a promising initiative.



# National Climate Predictions & Projections (NCPP) Platform

**Mission:** Supports state-of-the-art approaches to develop and deliver comprehensive regional climate information and facilitate its use in decision making and adaptation planning.

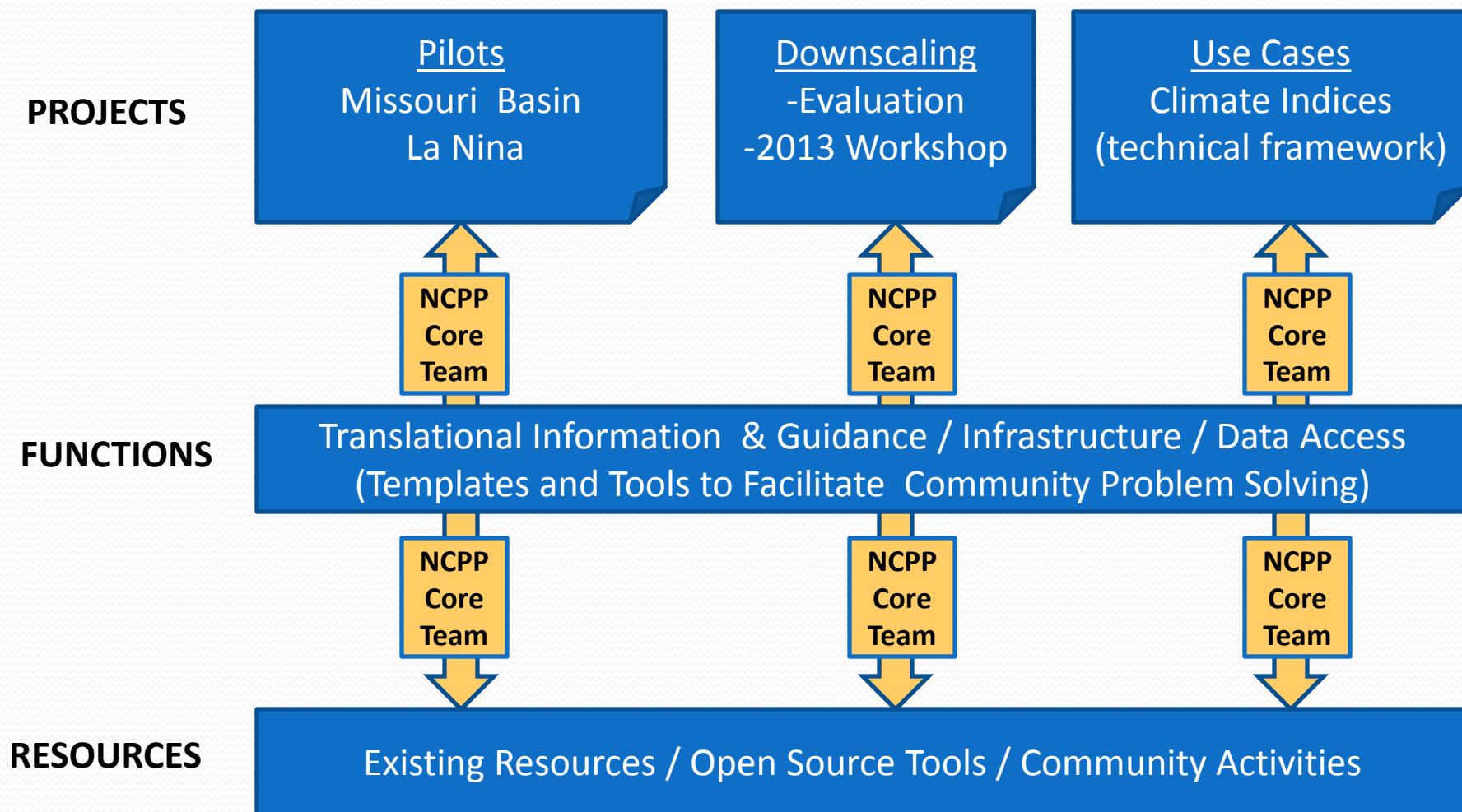
**Strategy:** A participatory community enterprise where climate information users, infrastructure developers, and scientists come together in a collaborative problem solving environment.

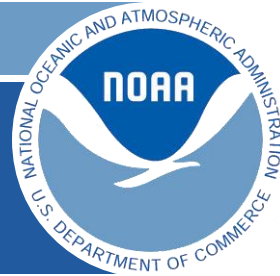






# NCPP Current Pilot Projects





# Summary

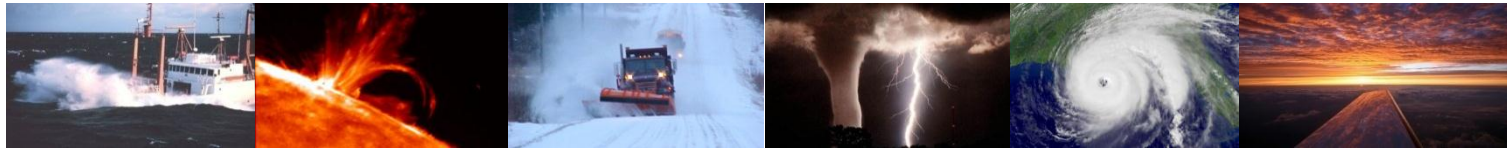
## *Climate Prediction Center*

- Delivers a suite of “operational” climate prediction, monitoring, and assessment products
- Accelerates advances in climate prediction and fills gaps in the “seamless suite” of climate products
- Works across NOAA and with other organizations on expanded responsibilities for climate; interdisciplinary approaches are the key to success
- Plays a unique and critical role in NOAA climate services



# Extras

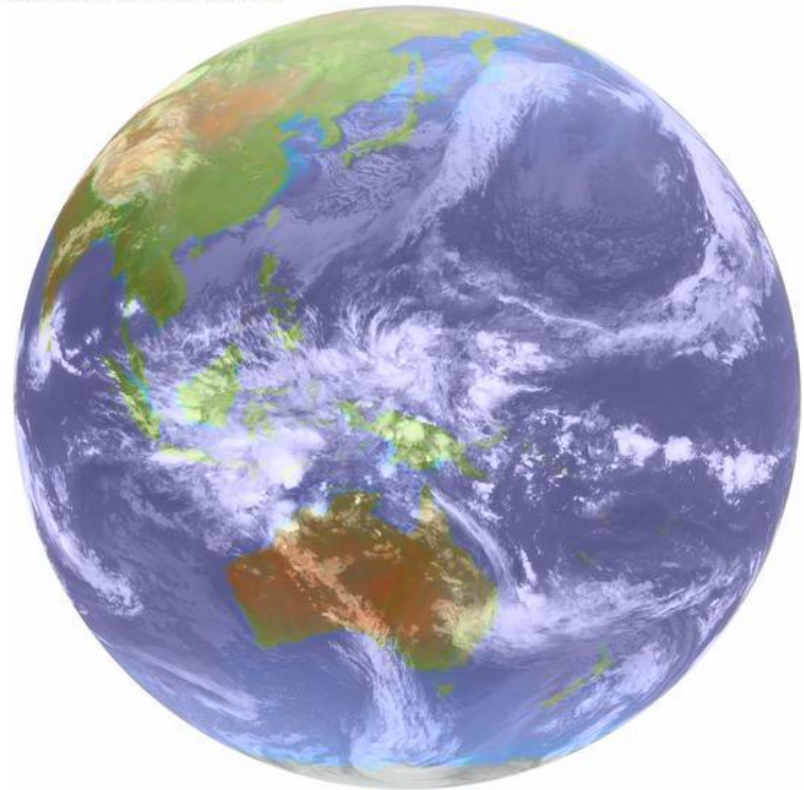
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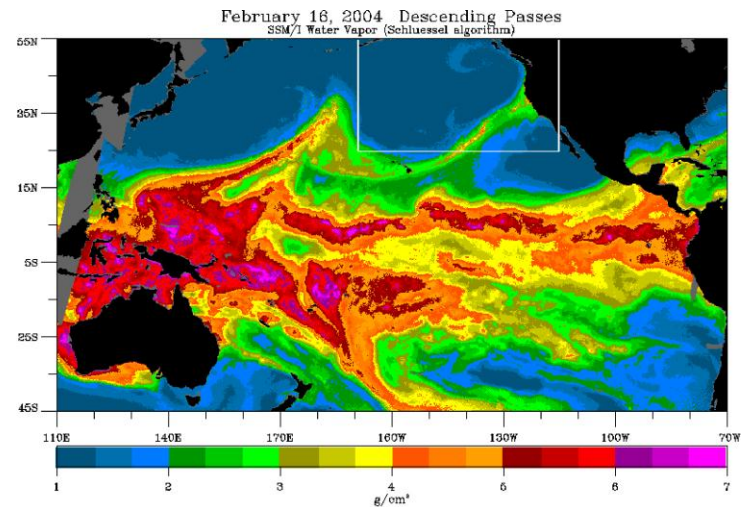
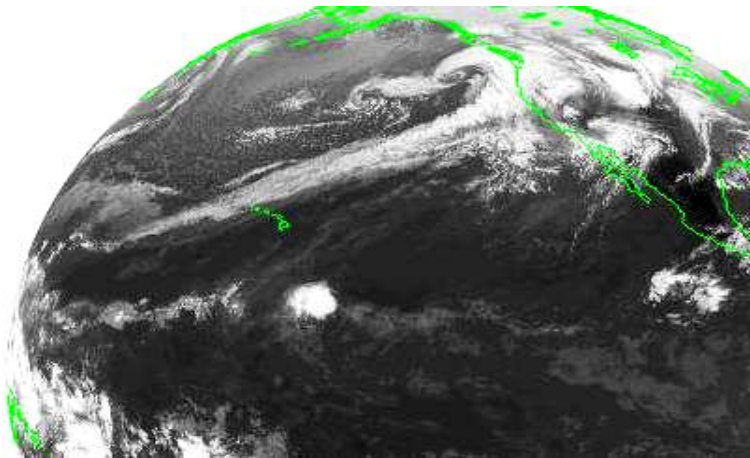
# Challenge 1: Organization of Tropical Convection

- A pervasive weakness of weather and climate models.
- Studies suggest that beyond 10 days, variations in tropical heating are a (the) major source of predictability, including weather events.
- Uncertainties associated with errors in cloud feedbacks appear very early in model integrations.

MTSAT -1R IR1 06030223JST Kochi Univ.

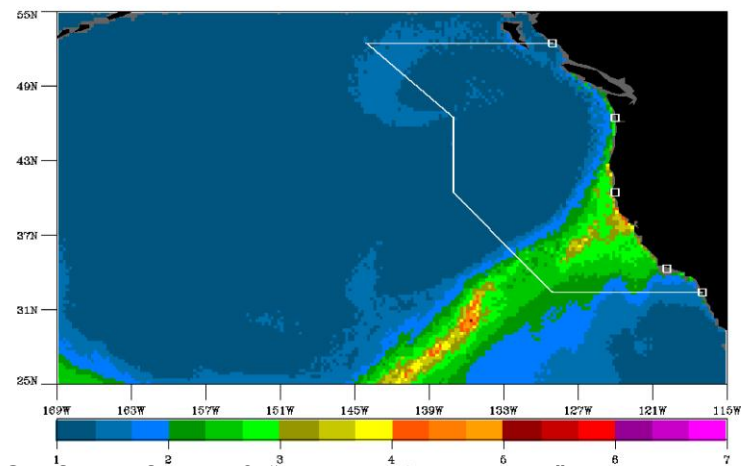


# Challenge 2: Tropical – Extratropical Interactions



Improve modeling & prediction of:

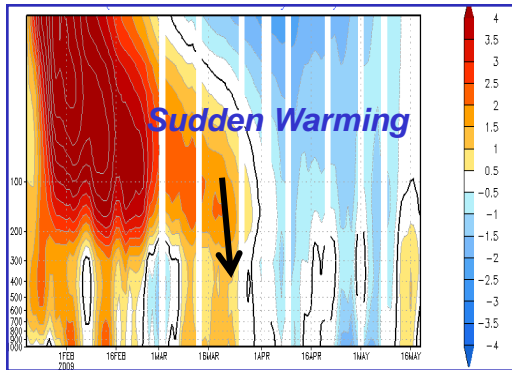
- Madden-Julian Oscillation
- “Atmospheric Rivers”
- “Pineapple Express” events
- Blocking and Storm Tracks
- Impacts: West Coast floods



California floods & “Atmospheric Rivers” (Bao et al 06) 29

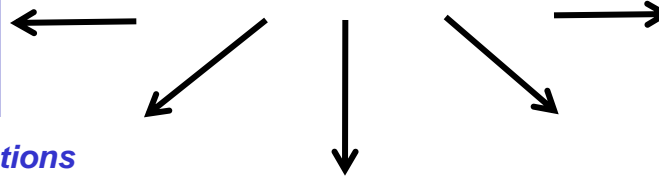


# Challenge 3: Exploit Sources of Predictability

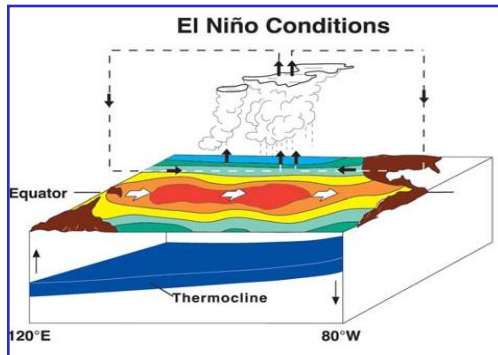


*Stratosphere – Troposphere Interactions*

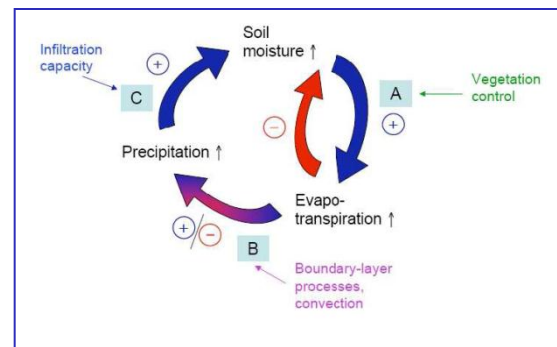
**Key sources that link  
climate to weather:**



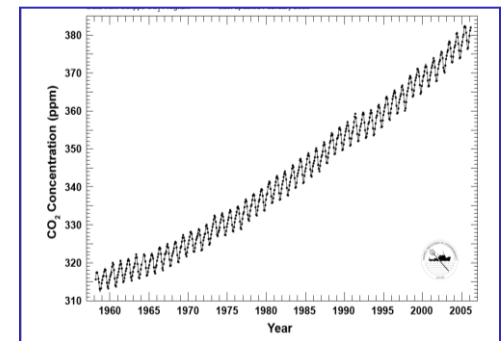
*Volcanic Eruptions ;  
Aerosols / trace gases*



*Ocean-Atmosphere Interactions;  
Role of sea-surface temperature*



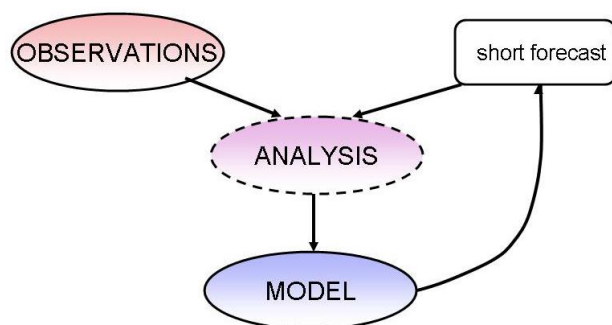
*Land -Atmosphere Interactions;  
Role of soil moisture & land processes*



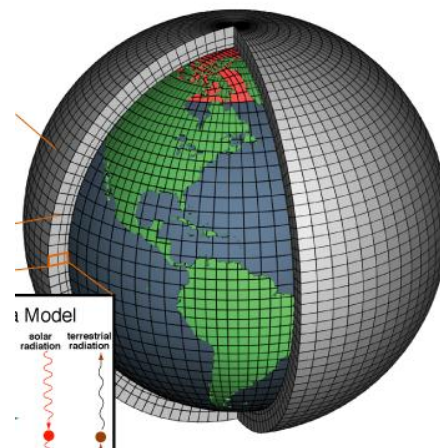
*Long-term Trends and  
Climate Variability*

# Challenge 4: Improve the “Building Blocks”

## Upgrade Data Assimilation Systems



## Identify / correct model errors



## Enhance Observational Networks



**Improvements in models, observational networks, and data assimilation systems lead to improved understanding and more realistic prediction over time.**

# Challenge 5: Implement “Best Practices”

**Enabling Mechanisms to accelerate improvements  
in weather and climate modeling and prediction:**

- **Collaboration between research and operations communities**
- **Archives**
- **Metrics**
- **Minimize subjective intervention**

